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(72) HEDBY, GUNNAR, SE
(72) KARLSSON, MATS, SE
(72) BALCK, KENNETH BO GUSTAF, SE
(71) TELEFONAKTIEBOLAGET LM ERICSSON, SE

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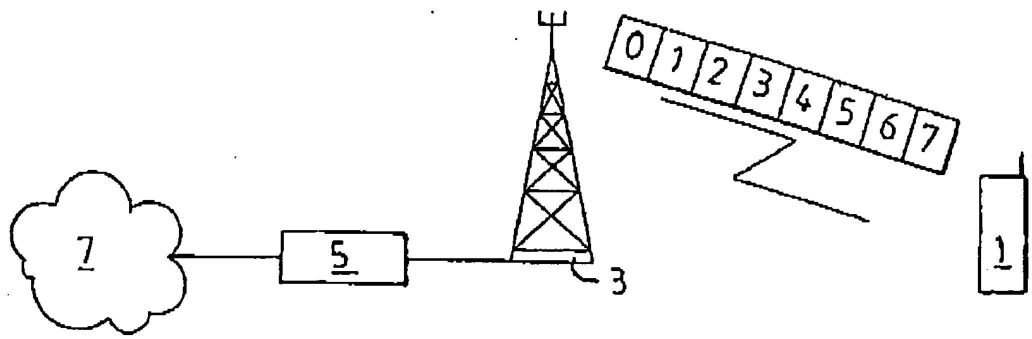
(54) PROCEDE ET APPAREIL D'ATTRIBUTION DE CANAUX DANS UN RESEAU MOBILE DE TELECOMMUNICATIONS A COMMUTATION DE PAQUETS ET DE CIRCUITS

(54) A METHOD AND APPARATUS FOR ALLOCATING CHANNELS IN A MOBILE TELECOMMUNICATIONS SYSTEM SUPPORTING BOTH PACKET AND CIRCUIT SWITCHED TRAFFIC



(57) L'invention porte sur un traitement efficace du trafic dans un système AMRT à commutation de circuits et de paquets. Ledit procédé comporte les étapes suivantes: spécification du nombre maximal de canaux attribuables pour chaque fréquence aux liaisons à commutation de paquets; spécification du nombre maximal de liaisons attribuables à un canal; et en cas de demande de liaison à commutation de paquets: vérification que le nombre maximal de canaux a été attribué et sinon attribution à la liaison des canaux disponibles, et si plus de canaux sont demandés, attribution à la liaison à commutation par paquets demandée, d'autres canaux pris parmi les canaux pouvant être attribués à des liaisons à commutation par paquets. L'invention porte également sur un noend de commande de réseau mobile de télécommunications comportant des programmes de mise en oeuvre dudit procédé.

(57) The present invention relates to the efficient traffic handling in TDMA systems using both circuit switched and packet switched traffic. The method according to the invention comprising the following steps: specifying a maximum number of channels that may be allocated to packet switched connections for each frequency; specifying a maximum number of connections that may be allocated to one channel; when a packet switched connection is requested, performing the following steps: checking if the maximum number of channels have been allocated and, if not, allocating the available channels to the connection; if more channels were requested, allocating other channels among the channels that may be allocated to packet switched connections to the requested packet switched connection. A control node in a mobile telecommunications network comprising programs for performing said method is also described.

A METHOD AND APPARATUS FOR ALLOCATING CHANNELS IN A MOBILE TELECOMMUNICATIONS SYSTEM SUPPORTING BOTH PACKET AND CIRCUIT SWITCHED TRAFFIC

The present invention relates to mobile telecommunications networks and in particular to the allocation of channels in such a network when both packet switched and circuit switched traffic is used in the network.

Description of Related Art

In many mobile telephony systems, for example the Global System for Mobile communication (GSM), protocols exist both for circuit switched and packet switched communication.

In circuit switched speech systems one or more physical channels are allocated to each connection. Each channel is assigned to one connection only, until the information transfer on this connection is completed. In GSM, the High Speed Circuit Switched Data (HSCSD) protocol enables the allocation of several physical channels to one connection, and is mainly used for transfer of large amounts of data.

In packet switched traffic data communication is often very intermittent and the information to be transferred occurs in bursts of varying length. During a burst, the bandwidth demand may be very high, whereas between bursts it may be zero. To utilize each channel optimally, a number of packet communication connections often share a number of physical channels.

The channel or channels assigned to a packet switched connection are assigned to a particular connection only when information is being transmitted on the connection. The rest of the time, the channel or channels can be used for the other connections assigned to the same channel or channels. The effective transmission rate for each connection is of course reduced if many connections share the same physical channels. Therefore, from a user's point of view it is beneficial not to share a channel with other users.

The circuit switched connections often carry speech, whereas the packet switched connections are mostly used for data. Therefore, the circuit switched connections must be transmitted in real time, while this is not so critical for the packet switched connections. Therefore, circuit switched connections are usually given a higher priority than packet switched connections. This means that, if the total number of channels requested is higher than the total number of available channels, packet switched connections may be disconnected to enable a circuit switched connection.

Depending on the traffic demand in the cell the number of channels required for each type varies with time. Therefore, the dynamic allocation of resources between circuit switched and packet switched traffic should be possible. Since the total number of channels in a cell is fixed, the number of channels allocated to each type of traffic has to be balanced, especially when the total traffic demand in a cell is high.

European Patent Specification EP 0 831 669 A2 describes a method for controlling the load of a Code Division Multiple Access (CDMA) system in which circuit switched and packet switched traffic occurs. The number of channels that may be allocated to each type of traffic can be set dynamically in dependence of the demand for each type of circuit switched and packet switched traffic, respectively.

The solution described in EP 0 831 669 A2 relates to the overall distribution of resources between circuit switched and packet switched networks. It does not, however, concern itself with optimizing the utilization of the channels that may be allocated to each of the two types of traffic.

Object of the Invention

It is an object of the present invention to enable the efficient traffic handling in TDMA systems using both circuit switched and packet switched traffic.

Summary of the Invention

This object is achieved according to the invention by a method of allocating channels in a mobile telecommunications system in which packet switched and circuit switched traffic may be used, said method comprising the following steps:

- specifying a maximum number of channels (TS_{MAX}) that may be allocated to packet switched connections for each frequency;
- specifying a maximum number of connections (NU_{MAX}) that may be allocated to one channel;
- when a packet switched connection is requested, performing the following steps:
  - checking if the maximum number (TS_{MAX}) of channels have been allocated and, if not, allocating the available channels to the connection;
  - if more channels were requested, allocating other channels among the channels that may be allocated to packet switched connections to the requested packet switched connection.

The object is also achieved by a control node in a mobile telecommunications network comprising programs developed to perform said method.

The method and control node according to the invention ensure that a certain number of channels are always reserved for circuit switched traffic, and at the same time guarantees that a reasonable number of packet switched connections share each of the channels that may be used for packet switched connections

According to a first embodiment, if the maximum number (TS_{MAX}) of channels have been allocated, it is checked if the maximum number (NU_{MAX}) of connections have been assigned to each of the channels among the channels that may be allocated to packet switched connections, and, if not, the channels having the fewest connections will be assigned to the requested connection.

If the maximum number (NU_{MAX}) of connections have been assigned to each of said channels, another frequency is selected.

According to a second embodiment, if the maximum number (TS_{MAX}) of channels have been allocated, it is checked if the maximum number (NU_{MAX}) of connections have been assigned to each of the channels among the channels that may be allocated to packet switched connections, and, if not, it is checked if the requested number of channels can be allocated to the connection and, if so, the channels having the fewest connections are assigned to the requested connection. If the requested number cannot be allocated to the connection, another frequency is selected.

In both embodiments, the steps are preferably performed for each frequency according to a priority order list, until a frequency is found on which the connection request can be fulfilled, or until the last frequency has been examined.

If no frequency is found on which the connection request can be fulfilled, the best possible assignment of channels is made, the connection is denied or the connection is assigned to channels that may not normally be allocated to packet switched connections.

The maximum number of channels (TS_{MAX}) that may be allocated to packet switched connections and/or the number of connections (NU_{MAX}) that may be assigned to each channel may be set individually for each frequency. This enables the establishment of a limited number of packet switched connections with a high bandwidth without increasing the total number of channels that may be assigned to packet switched connections too much.

If a circuit switched connection is requested for which no channels are available among the channels that may not be used for packet switched connections and, the

necessary number of channels that may be used for packet switched connections are allocated to the circuit switched connection.

One or more packet switched connections may be disconnected to make idle channels for the circuit switched connection.

This ensures that the circuit switched connections are always given a higher priority than the packet switched connections, which do not require real-time communication.

Brief Description of the Drawings

The present invention will be described in more detail in the following, by way of preferred embodiments, and with particular reference to the drawings, in which

Figure 1 illustrates the communication between a mobile terminal and a base station terminal in a TDMA system;

Figure 2 is a flow chart of the inventive method;

Figures 3A-3E illustrate the use of the inventive method for allocating channels to one frequency.

Detailed Description of Embodiments

Figure 1 illustrates the communication between a mobile terminal 1 and a base station 3 in a mobile telecommunications system according to TDMA. A number of channels, are transmitted in time slots on the same frequency. In the Figure, eight time slots, corresponding to eight physical channels, are transmitted on the same frequency. The base station 3 is controlled by a base station controller 5, through which it is connected to a telecommunications network 7. This description is, however, only concerned with the communication between the mobile terminal 1 and the base station 3.

A circuit switched connection is assigned one or more physical channels, and occupies this channel or these channels alone for the duration of the connection. A

packet switched connection is assigned one or more physical channels, which it shares with other packet switched connections.

In the discussion below the following definitions are used:

NU_{MAX}: The maximum number of packet switched connections that can be accommodated for each time slot.

TS_{MAX}: The maximum number of time slots on one frequency that may be allocated for packet switched connections. If the TS_{MAX} criterion is fulfilled for a frequency, this means that at least this number of time slots on this frequency is allocated to packet switched connections.

Area The area criterion is fulfilled for a given frequency if there are at least NU_{MAX} connections assigned to all the channels that may be allocated to packet switched connections on that frequency.

Both NU_{MAX} and TS_{MAX} may be given different values for different frequencies. This may be used to make the system more flexible. For example, the value for TS_{MAX} may be set relatively low for most frequencies, while a few frequencies may have a higher TS_{MAX} to enable packet switched connections with higher bandwidth on these few frequencies.

NU_{MAX} and TS_{MAX} are used together to determine when a new frequency should be selected for new packet switched connections to be set up. They may be set by the operator and may be changed when the traffic situation changes.

Two fundamental assumptions are made, which are true for most TDMA systems:

1) A priority order has been defined for the allocation frequencies to circuit switched and packet switched traffic, respectively.
2) In the case of congestion, circuit switched traffic has a higher priority than packet switched traffic. This means that, if more than the available number of channels

are requested a channel used for packet switched connections may be pre-empted to make room for a circuit switched connection.

If TS_{MAX} has different values for different frequencies, different priority lists may be used. For example, the first frequency examined may always be the frequency for which TS_{MAX} is equal to the number of channels requested.

Figure 2 is a flow chart of the method according to the invention. In the initial situation all channels are either idle or used for circuit switched connections.

Step S1: A packet switched connection utilizing a number N of channels is requested.

Step S2: Select the first frequency in the above mentioned priority list.

Step S3: Is the TS_{MAX} criterion fulfilled for this frequency? If no, go to step S4; if yes, go to step S5.

Step S4: Allocate the channels that may be allocated to packet switched connections and that are not currently allocated to any connection on this frequency to the connection. If more channels are requested, go to step S6, otherwise, end of procedure.

Step S5: Is the Area criterion fulfilled for this frequency? If no, go to step S6; if yes, go to step S7.

Step S6: Assign the requested number of channels on this frequency to the packet switched connection, or, if the number of channels requested is higher than TS_{MAX}, assign TS_{MAX} channels. The channels are selected as the ones that have the fewest connections allocated to them among the ones already used for packet switched connections. End of procedure.

Step S7: Is this the last frequency in the priority list? If yes, go to step S8, if no, go to step S9.

Step S8: Make the best possible assignment of channels.

Step S9: Select the next frequency in the priority list as the current frequency. Go to step S3.

In step S8, that is, if the TS_{MAX} and the Area criteria are fulfilled for all frequencies, alternative actions are possible. In the flow chart it has been assumed that the connection is assigned to channels already having more than NU_{MAX} connections assigned to them. It would also be possible to deny the connection altogether, to guarantee a minimum bandwitdh to ~~each connection~~ actually set up. A third possibility would be to assign channels that may not normally be used for packet switched connections to the connection.

Figures 3A-3E illustrate the allocation of channels according to the procedure described above. In these figures TS_{MAX} is set to four and NU_{MAX} is set to three. This means that, of the eight channels available on the frequency shown, four may be allocated to packet switched connections. Three connections may share one physical channel before it will be considered to allocate a newly requested connection to a new frequency.

Figure 3A shows the situation when there is only one connection on the frequency. Two channels have been allocated to the connection, as indicated by the two boxes with diagonal shading.

Figure 3B shows the situation after a second connection has been established. Three channels have been assigned to this connection, as indicated by three boxes with vertical shading. Since fewer than TS_{MAX} (that is, four) channels were allocated to packet switched data before this connection was set up, the connection uses the two channels that were not previously used and shares one channel with the first connection.

Figure 3C shows the situation after the establishment of a third connection using four time slots. Since all the four channels allocated to packet switched connections already had been assigned, a check was made to see if the Area criterion was ful-

filled, that is, if the maximum number of connections had already been assigned to each channel. Since this was not the case, all the four channels of the frequency that may be allocated to packet switched connections have been allocated to the connection, as indicated by the dotted shadow squares.

Figure 3D shows the situation after two more one-channel connections have been allocated. The time slots used are shown as black squares. Now all the channels except one have the maximum number of connections assigned to them.
If a connection request for two or more channels is made at this stage, there are two alternatives:

1) The connection may be set up on this frequency, which means that on two channels there will be one more than NU_{MAX} (that is, three) connections. This is the situation shown in Figure 3E.

2) Another frequency may be selected for the new connection, since it cannot be set up on this frequency without violating the Area criterion.

The functions described above may be implemented as software packages included in a node in the network. A separate node may be included, or the functions may be implemented in an existing node, for example, the base station controller 5 shown in Figure 1.

Claims

1. A method of allocating channels in a mobile telecommunications system in which packet switched and circuit switched traffic may be used, characterized by the following steps:

- specifying a maximum number of channels (TS_{MAX}) that may be allocated to packet switched connections for each frequency;
- specifying a maximum number of connections (NU_{MAX}) that may be allocated to one channel;
- when a packet switched connection is requested, performing the following steps:
  - checking if the maximum number (TS_{MAX}) of channels have been allocated and, if not, allocating the available channels to the connection;
  - if more channels were requested, allocating other channels among the channels that may be allocated to packet switched connections to the requested packet switched connection.

2. A method according to claim 1, comprising the subsequent step of, if the maximum number (TS_{MAX}) of channels have been allocated: checking if the maximum number (NU_{MAX}) of connections have been assigned to each of the channels among the channels that may be allocated to packet switched connections, and, if not, allocating the channels having the fewest connections to the requested connection.

3. A method according to claim 2, wherein, if the maximum number (NU_{MAX}) of connections have been assigned to each of said channels, another frequency is selected.

4. A method according to claim 1, comprising the subsequent step of, if the maximum number (TS_{MAX}) of channels have been allocated:

checking if the maximum number (NU_{MAX}) of connections have been assigned to each of the channels among the channels that may be allocated to packet switched connections, and, if not,

checking if the requested number of channels can be allocated to the connection and, if so,

allocating the channels having the fewest connections to the requested connection.

5. A method according to claim 4, wherein, if the requested number cannot be allocated to the connection, another frequency is selected.

6. A method according to any one of the preceding claims, wherein the steps are performed for each frequency according to a priority order list, until a frequency is found on which the connection request can be fulfilled, or until the last frequency has been examined.

7. A method according to claim 6, wherein, if no frequency is found on which the connection request can be fulfilled, the best possible assignment of channels is made.

8. A method according to claim 6, wherein, if no frequency is found on which the connection request can be fulfilled, the connection is denied.

9. A method according to claim 6, wherein, if no frequency is found on which the connection request can be fulfilled, the connection is assigned to channels that may not normally be allocated to packet switched connections.

10. A method according to any one of the preceding claims comprising the steps of, if a circuit switched connection is requested,

checking if the requested number of channels are available among the channels that may not be used for packet switched connections and, if so, assigning the requested number of channels among these channels to the connection.

11. A method according to claim 8, wherein, if the requested number of channels are not available among the channels that may not be used for packet switched connections, the necessary number of channels that may be used for packet switched connections are allocated to the circuit switched connection.

12. A method according to claim 9, wherein, if no idle channels are available for a requested circuit switched connection, one or more packet switched connections are disconnected to make idle channels for the circuit switched connection.

13. A method according to any one of the preceding claims, wherein the maximum number of channels (TS_{MAX}) that may be allocated to packet switched connections and/or the number of connections (NU_{MAX}) that may be assigned to each channel may be set individually for each frequency.

14. A control node in a mobile telecommunications system characterized in that it comprises

- memory means holding a values (TS_{MAX}, NU_{MAX}) specifying a maximum number of channels that may be allocated to packet switched connections for each frequency and a maximum number of connections that may be assigned to one channel, respectively;
- means for, when a packet switched connection is requested:
  - checking if the maximum number (TS_{MAX}) of channels have been allocated and, if not, allocating the available channels to the connection;
  - if more channels were requested, assigning other channels among the channels that may be allocated to packet switched connections to the requested packet switched connection.

15. A control node according to claim 14, arranged to, if the maximum number (TS_{MAX}) of channels have been allocated:
check if the maximum number (NU_{MAX}) of connections have been assigned to each of the channels among the channels that may be allocated to packet switched connections, and, if not, allocate the channels having the fewest connections to the requested connection.

16. A control node according to claim 15, arranged to, if the maximum number (NU_{MAX}) of connections have been assigned to each of said channels, select another frequency.

17. A control node according to claim 14, arranged to,
if the maximum number (TS_{MAX}) of channels have been allocated:
check if the maximum number (NU_{MAX}) of connections have been assigned to each of the channels among the channels that may be allocated to packet switched connections, and, if not,
check if the requested number of channels can be allocated to the connection and, if so,
assign the channels having the fewest connections to the requested connection.

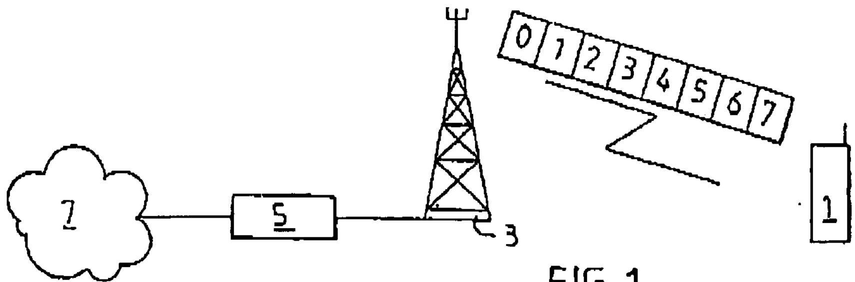


FIG. 1

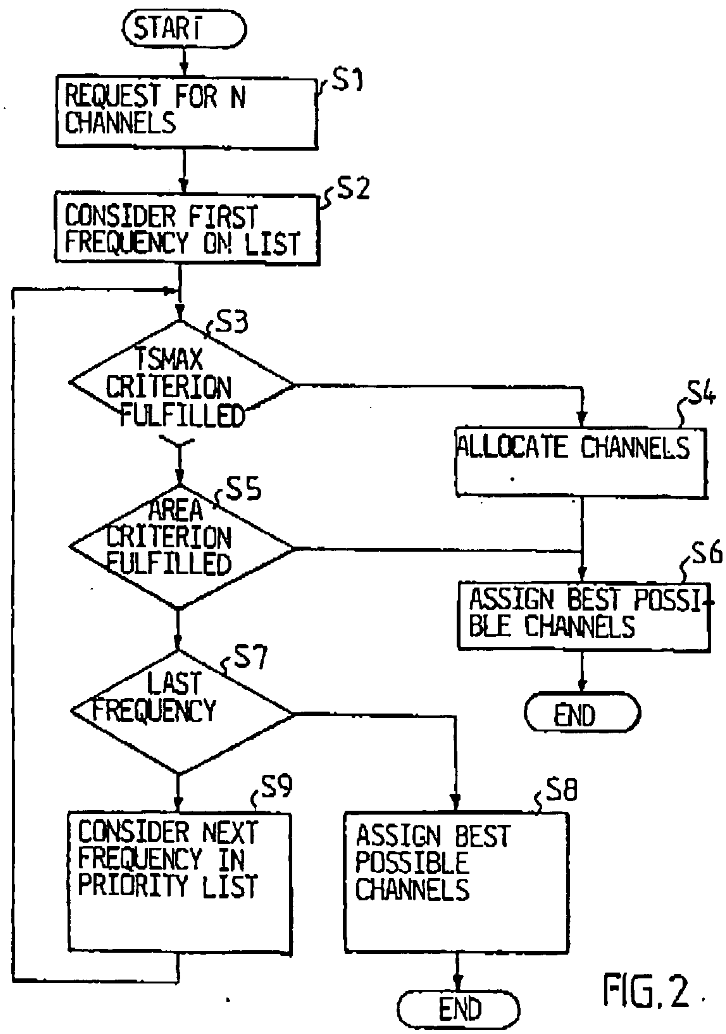


FIG. 2

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Marks E. Clark

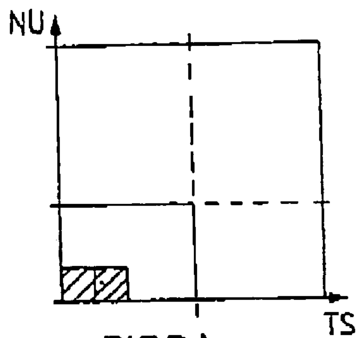

FIG.3A

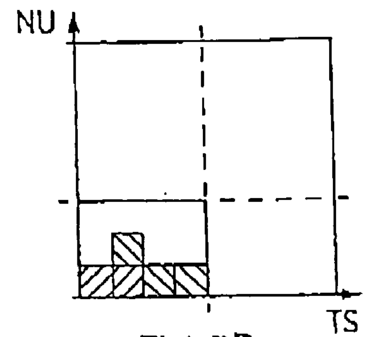

FIG. 3B

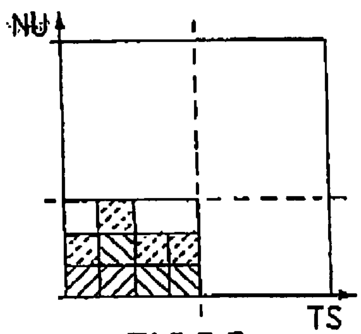

FIG.3C

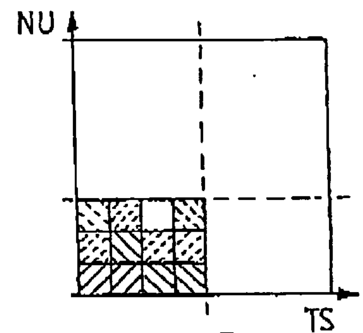

FIG. 3D

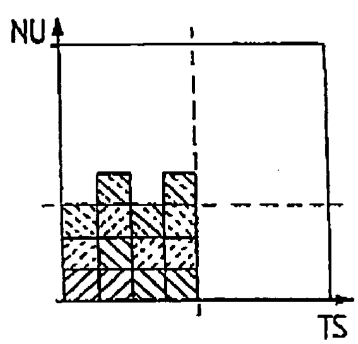

FIG.3E

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